Report for 2002AR11B: Chemical Variation of Water From The Alluvial Aquifer

- Conference Proceedings:
  - Steele, K. F., Davis, R.K, and Kresse, T.M., in press. Spatial and temporal nitrate concentration variability within the Mississippi River Valley alluvial aquifer on a small scale at selected Arkansas, USA Sites, in Proceedings of the 7th International Specialized Conference on Diffuse Pollution and Basin Management, University College Dublin.
  - Steele, K. F., Davis, R.K, and Kresse, T.M., in press. Small-scale spatial variation of water quality within the Mississippi River Valley alluvial aquifer, Arkansas, USA in 4th Joint IH-CNC/CGS Groundwater Specialty Conference, Winnipeg, Manitoba, Canada, Conference Proceedings.

Report Follows:

Problem and Research Objectives

Many studies of the alluvial aquifer have noted spatial variability of ground-water chemistry on regional or county scale. These data have often been represented on contour maps of specific conductance, chloride and other ions. Until this project, there had been no studies of small-scale spatial and temporal variability of the alluvial aquifer water chemistry in Arkansas. In order to compare water quality among aquifers, it is critical to determine the density of the wells necessary to represent the aquifers and to establish meaningful contour intervals for parameter values. The impact of season also must be determined so that appropriate sample collection dates and frequency may be selected. Furthermore, there have been comparisons of water quality between shallow and deep wells, but this has rarely been done on small-scale.

The objective of this project was to ascertain the spatial and temporal variability of ground-water chemistry from the alluvial aquifer, Arkansas on a small-scale.

Methodology

Wells at three sites in three counties in eastern Arkansas were used in this project. The distribution of the wells used in this study are as follows: (1) three monitoring wells and three irrigation wells at a site in Monroe County, (2) three monitoring wells, a domestic well and three irrigation wells at a Pulaski County site, and (3) four monitoring wells and a domestic well at the Woodruff County site. Samples were collected for the shallow wells at Monroe and Pulaski Counties on June 25 and 26, 2002 and the shallow wells and the nearby deep irrigation wells were sampled on August 11 and 12, 2002. There were existing data for the Woodruff county site from a June 18, 1996 collection date. There were also an additional 8-10 additional historical analyses for nitrate concentrations at the Monroe and Pulaski County sites. The samples collected in 2002 and the historical nitrate collection dates were classed as either recharge (e.g., June samples) or non-recharge (e.g., August samples) conditions in order to determine the impact of recharge conditions (season) on the water chemistry.

The ground-water samples were collected and analyzed under standard methodology and quality assurance procedures. The AWRC Water Quality Laboratory performed all of the analyses except for the samples from Woodruff County, which were analyzed by the Arkansas Department of Environmental Quality.

Principal Findings and Significance

Because there are differences in the chemical processes affecting the major ions and nitrate, nitrate will be discussed separately. Shallow wells exhibited significant spatial variation for Ca, Mg, Na, HCO_3, Cl, and SO4. These ions have maximum concentrations 1.4 to 6.8 times the minimum concentration for shallow wells. Some temporal variation occurs for shallow wells at one site, the maximum to minimum concentration ratios range from 1.3 to 4.7. Deep wells have ion concentrations similar to shallow wells, but generally, the ions have smaller concentration ranges. Heterogeneous mineral and organic carbon abundances, and variable residence times, which affect amount of mineral dissolution and cation exchange, have a major impact on the water chemistry. These factors are the result of discontinuous sedimentary units with variable thickness and extent that affect ground-water movement. Other factors affecting the water chemistry are recharge conditions and fluctuating water table depths that change ground-water flow directions, and that allow de-watering of saturated fine-grained sedimentary units when the water table is declining.

There is significant spatial and temporal variability of nitrate. Spatial variability is as great as 0.04 to 14.45 mg/L NO_3-N, and temporal (45 days) variability in a well is as great as 0.11 to 14.45 mg/L NO_3-N. Deeper wells generally have low nitrate concentrations. The variation of nitrate concentrations can be explained by transport of nitrate from fertilizer to the ground-water system and subsequent denitrification within the alluvial aquifer.